Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

# Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin

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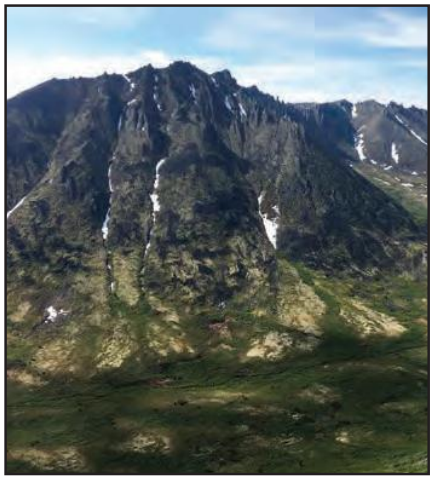

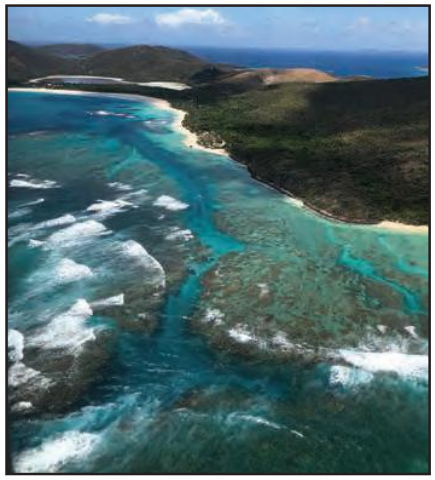

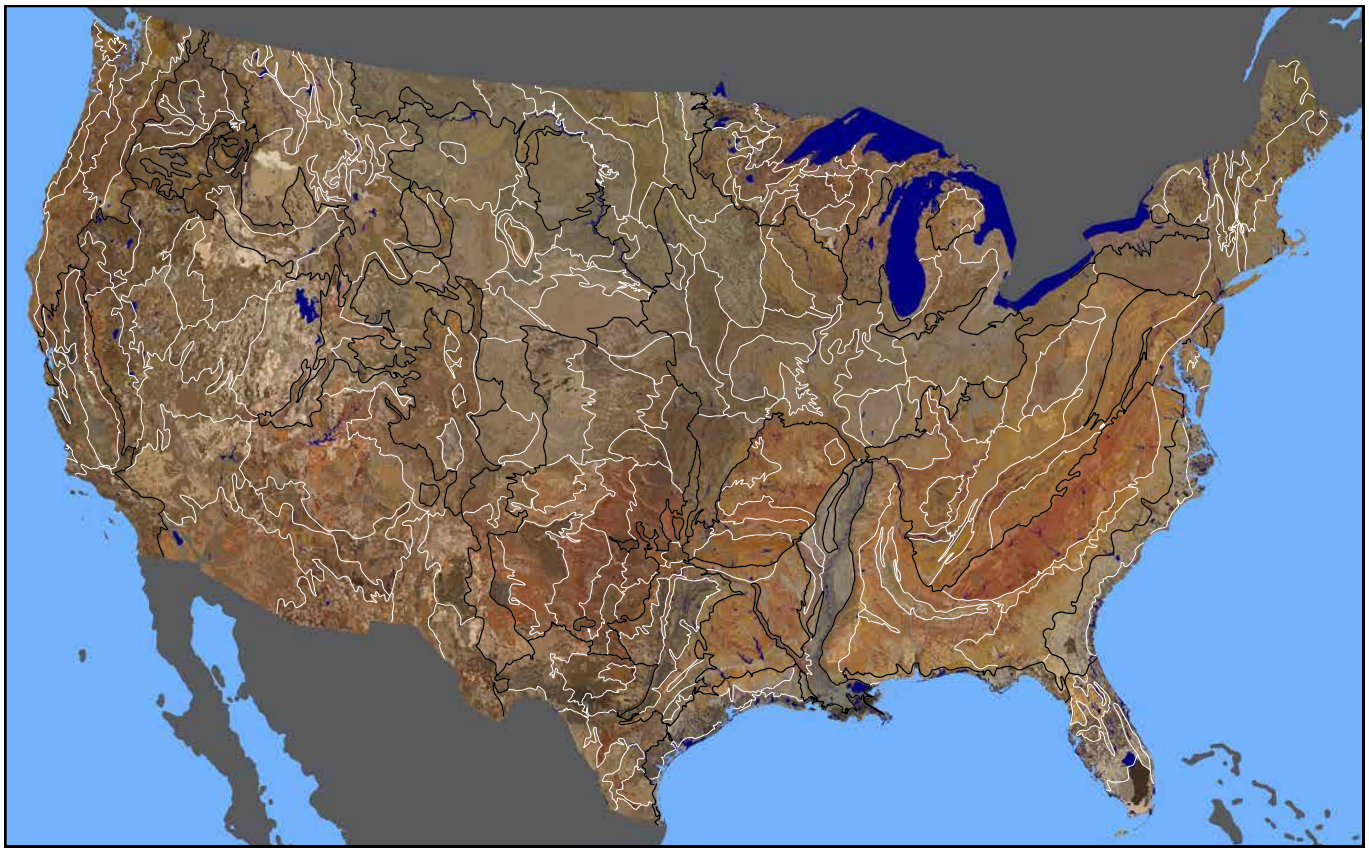

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Natural Resources Conservation Service

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**Inside cover:** Upper left—A landscape in Interior Alaska (Land Resource Region X1). Upper middle— A landscape in the Caribbean Region (Land Resource Region Z). Upper right—A landscape in Hawaii Region (Land Resource Region V). Bottom—Map of actual soil colors at a depth of 75 centimeters overlain by the boundaries of land resource regions (black lines) and major land resource areas (white lines) for the conterminous United States.

**Additional imagery:** Photographs and block diagrams for many of the areas described in this document are available at the website of the National Soil Survey Center (https://www.nrcs.usda.gov/wps/portal/nrcs/site/soils/home/). Search for "Major Land Resource Area" on the site.

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# Preface

Natural vegetation is a result of the combination of geography, soils, and climate. Ancient peoples learned that soils that produced grass and trees could also produce grain, fruits, and vegetables. Soil scientists recognized these relationships. Some of their earliest publications included a description of the climate and vegetation (or crop types) typical for particular soils, for example, "Chestnut soils of the temperate to cool semiarid regions of grain and cattle grazing." Different social, economic, and political cultures can be considered outgrowths of the various types of soils, crops, and climate that occur in different regions. For example, the lives of cattle ranchers in western South Dakota are in sharp contrast to the lives of potato farmers in northern Maine.

Early farmers and ranchers realized that different soils and climates determined the types of crops they could economically produce. Terms such as "Corn Belt" and "Cotton Belt" were coined because of the crops typically grown by pioneering settlers in certain areas. These areas were essentially the original versions of land resource areas. As soil mapping progressed across the country, soil scientists worked with other natural resource managers to subdivide land into resource units with similar soils, climate, and vegetation or crop types. As a result, a few soil scientists and natural resource planners were able to provide useful soil interpretations and soil conservation recommendations to many landowners in a region instead of just a few individuals.

The first edition of Agriculture Handbook 296 was published in 1965. It presented subdivisions of the United States as several land resource regions made up of many major land resource areas. Because each land resource region had similar climate, soils, and land use activities, natural resource planners could target efforts in education and financial and technical assistance on a regional basis. Agriculture Handbook 296 was used in making decisions about regional and national agriculture and helped to identify the need for research and resource inventories. It became the vehicle for applying research results across political boundaries. It also became the basis for organizing and operating natural resource conservation programs.

# Acknowledgements

More than 200 soil scientists, ecologists, GIS specialists, data quality specialists, and editors contributed directly to the data presented in this volume. Staff at the National Soil Survey Center, the regional update leaders (points of contact), and the regional directors involved in the production of this volume are listed below. Others that provided detailed knowledge about physiography, geology, climate, water resources, soils, or biological resources; land use data; imagery; and the central concepts and nature of boundaries are listed alphabetically under Contributors.

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# Introduction

United States Department of Agriculture Handbook 296 is a broadscale synthesis of current knowledge about land areas based on patterns of physiography, geology, climate, water resources, soils, biological resources, and land use (Austin, 1965). These patterns were used to establish the unique central concept and boundaries for each land resource region (LRR) and major land resource area (MLRA). This handbook is designed primarily for use in developing soil and water conservation programs at the continental scale (using the LRR concept) and the inter-State scale (using the MLRA concept).

The LRR is the highest level of a hierarchal segmentation of land areas of the United States and its territories (National Soil Survey Handbook, Part 649). Because of their large size, LRRs are delineated at a scale of 1:7,500,000 for the conterminous United States and Alaska and at a scale of 1:1,000,000 for the islands (see accompanying LRR-MLRA map). There are 28 LRRs: 20 in the conterminous United States, 5 in Alaska, and 1 each for Hawaii, the Caribbean, and the Pacific Basin Islands. The largest LRR is "D," which consists of 1,420,100 square kilometers (548,305 square miles) (fig. 1). The smallest is "Q" (the Pacific Basin Islands), which consists of 2,295 square kilometers (885 square miles).

The MLRA is the second-level hierarchal segmentation of land areas of the United States. MLRAs are delineated at scales of 1:7,500,000 to 1:1,000,000 (see accompanying LRR-MLRA map) and are useful for State-wide, inter-State, and regional planning. There are 267 MLRAs, ranging in size from MLRA 35 (Colorado Plateau), which consists of 181,855 square kilometers (70,215 square miles), to MLRA 196 (Coral Atolls of Micronesia), which consists of 11 square kilometers (3 square miles).

This edition of the handbook is designed for publication in traditional book form, for the purposes of longevity and conciseness, as well as in an electronic form available online. Future iterations should become more frequent and easier as the hierarchy system becomes digitized in a database format. For the current edition, the linework is digitally available on the Geospatial Data Gateway with tabular data linked to other databases, such as the National Soil Information System (NASIS) and the Ecosystem Dynamics Interpretive Tool (EDIT).

The three previous editions of Agriculture Handbook 296 were published in 1965, 1981, and 2006. The 1965 edition evolved from the 1950 map entitled "Problem Areas in Soil Conservation" (Austin, 1965). It was designed primarily for use by the Soil Conservation Service. This edition presented 20 LRRs that were labeled from northwest to southeast using letters, beginning with "A" for the Pacific Northwest and ending with "U" for Florida. It presented 156 MLRAs that were numbered consecutively, beginning with "1" in the Northern Pacific Coast Range and ending with "156" in the Florida Everglades. Concepts for LRRs and MLRAs were based on the combination of five factors: (1) land use, (2) elevation and topography, (3) climate, (4) water, and (5) soil.

The 1981 edition expanded LRR descriptions to include Hawaii (LRR V) and Alaska (LRRs W, X, Y). New MLRAs were created from subdivisions of the original 156 MLRAs and identified by symbols that included a letter. For example, MLRA 58 was subdivided into four new MLRAs: 58A, 58B, 58C, and 58D. In the second edition, MLRA concepts were based on the original five factors as well as a sixth factor: potential natural vegetation.

The 2006 edition added LRR Q (the Pacific Basin Islands) and included additional LRRs for Alaska (W1, W2, X1, X2), designated by both a letter and a number because all the letters in the alphabet were already used. New MLRAs were again created by subdivision of previous MLRAs and labeled with a letter added to the number. This edition contained 278 MLRAs. Two notable developments in this edition were the addition of geology as a factor in the MLRA concept and the reordering of the factors. Land use, for example, which was listed first in both the 1965 and 1981 editions, was now listed seventh.

LRR and MLRA concepts are similar but not identical to the Environmental Protection Agency (EPA) ecoregions and the Forest Service (USFS) ecological units (Omernik, 1987; US EPA, 2003; Cleland et al., 2005; McNab et al., 2005). The purpose of the LRR and MLRA concepts is to provide the knowledge needed to make decisions about national and regional agricultural concerns, provide a basis for resource inventories and extrapolating research results, and serve as a framework for organizing and operating soil surveys and resource conservation programs. The purpose of the EPA's ecoregion concept is to provide a spatial framework for assessing and regulating surface water quality, facilitating ecosystem management, and increasing environmental understanding. The concept of the Forest Service's ecological unit is a scale-based, nested hierarchy in which progressively

more specific ecological units are developed as a vegetation classification system (Salley et al., 2016a). Significant overlap, however, occurs between NRCS mapping, which focuses on soil properties, and Forest Service mapping, which focuses on the Terrestrial Ecological Unit Inventory (TEUI) that distinguishes units based on geology, climate, soils, hydrology, and vegetation (USFS, 2005). Both systems involve mapping at multiple spatial scales for inventory and land use planning.

In this edition of the handbook, a location map is provided for each LRR and MLRA. Descriptions of the central concept, boundaries, climate, soils, and land use are provided for each LRR. In addition to the central concept and the boundaries, the MLRA descriptions provide a summary of physiography, geology, climate, water, soils, biological resources, and land use. Information for the central concepts and the physiography section is based mainly on Fenneman and Johnson (1946), Wahrhaftig (1965), Thornbury (1965), and Hunt (1967). Information on bedrock and surficial geology for each MLRA was derived from a wide variety of State and Federal maps and reports. Information on climate, water, soils, biological resources, and land use are based on sources listed in the reference section.

This update of Agriculture Handbook 296 was driven by the need to improve the usability of the land resource hierarchy system so that a more consistent application of soil-ecological-landscape concepts could provide more accurate and efficient application of conservation on the ground. It involved innovations to the current system through incorporation of updated climate, elevation, soil, and land use data and improvement in linework accuracy based on advances in remote sensing and geographic information systems (GIS). The update has also been driven by the need to fit ecological sites into the hierarchy of LRRs, MLRAs, and LRUs (land resource units) (Salley et al., 2016b). This edition retains the labeling convention of the three previous versions because: (1) the current names are familiar to practitioners working with MLRAs, (2) retaining the labels does not necessitate extensive changes in the databases, and (3) the labeling convention provides a straightforward method for creating new MLRAs by subdividing existing ones or recombining smaller ones that are more appropriate as land resource units back into a larger MLRA (National Soil Survey Handbook, Part 649).

Land resource units generally are several thousand acres in size and are the basic units from which MLRAs are determined. LRUs are typically, but not necessarily, coextensive with State general soil map units. Being too numerous and too small to be designated at a scale of 1:7.5 million, LRUs are not listed and described in this publication. They are mentioned here, however, because of their importance in providing a structured framework for soil survey projects, developing ecological site descriptions (ESDs), and facilitating correlation, especially in the West. Beginning in 2005, LRUs were temporarily designated as common resource areas (CRAs) within NRCS.

Climate is one of the seven factors that determine the LRR and MLRA boundaries. As climate is changing (IPCC, 2018), many boundaries will shift, particularly those separating the shrublands and grasslands, the grasslands and woodlands, and the woodlands and forests. In humid regions, the thermic boundary and its associated species will continue expanding at the expense of the mesic temperature regime, the mesic at the expense of the frigid, and the frigid at the expense of the cryic. This edition of Agriculture Handbook 296, along with its predecessors, can serve as baseline data for future generations to assess the degree of environmental change and need for adaptive strategies.

# Changes in This Edition

## Line Adjustments

Modifications to cartographic boundaries were made to accommodate new ideas or changes to the LRR or MLRA concepts that arose from issues in the usability, consistency, or ambiguity of older concepts. Changes to the boundaries of LRRs and MLRAs involved modifications by NRCS staff serving as points of contact (POCs), as assigned by the directors of the 13 soil survey regions. The POCs worked on the line adjustments with field soil scientists, ecological site specialists, State soil scientists, conservationists, and other cooperators within the National Cooperative Soil Survey. Line changes were submitted to the GIS specialist at the National Soil Survey Center, who then created a national map. The national map was then sent back to the POCs for assessment. Several iterations of this process took place. The POCs and their associates also updated the narratives.

The accompanying fold-out map was made by overlaying the LRR and MLRA linework on a hillshade base map. Colors used to identify the LRR polygons and MLRA symbols were based on standard NRCS base colors. The legend was made with GIS software (i.e., ArcMap) and exported as a SVG (scalable vector graphics) file. The SVG file was imported into open-source vector graphics software (i.e., Inkscape), which was used to create LRR and MLRA titles, symbols, patches, and names.

## Line Smoothing

The goal of generalizing the lines was to make them cartographically appropriate at the 1:7,500,000 scale. A smoothing process was applied to the MLRA delineations (which were commonly coincidental with general soil map units) after the revisions were applied to the 2006 edition of the spatial data. The smoothing process eliminated jagged lines and small delineations of outliers, such as isolated mountain peaks, valleys, and coastal islands surrounded by water. For this reason, the reader is cautioned about using these maps for detailed information. The details of these small polygons are available in SSURGO (Soil Survey Geographic Database).

## Addition of New MLRAs and Recombination of Small MLRAs

The formation of new MLRAs and the combination of others were a major part of the updating process. The 19 new MLRAs are 42A, 42B, 42C, 44A, 44B, 55D, 56A, 56B, 85A, 85B, 91, 95, 102D, 107, 108, 111, 114, 115, and 133C. In addition, MLRA 95 was moved from LRR K to LRR L. Recombined small MLRAs, which will be labeled "obsolete" in the NASIS database, include 20, 31, 42, 44, 56, 70C, 70D, 85, 91A, 91B, 95A, 95B, 102B, 107A, 107B, 108A, 108B, 108C, 108D, 111A, 111B, 111C, 111D, 111E, 114A, 114B, 115A, 115B, 115C, 221, and 235.

## Central Concepts and Boundaries

The core idea and nature of boundaries are described for each LRR and MLRA. Other changes to the narrative include the addition of tables showing the extent of the MLRAs. Information on cities, highways, parks, and national forests was removed except where it added to the understanding of the central concept and boundaries. Also removed were data on withdrawals of freshwater and the parts per million of total dissolved solids. For this data, the reader can refer to U.S. Geological Survey (USGS) reports. The section on soils now presents information on the main series and their classification as lists rather than in narrative form.

## Thematic Maps of Soil Properties

Maps of soil properties, such as argillic horizons and restrictive layers, have been added to elucidate LRR and MLRA boundaries and provide visual information for continental-scale interpretations. These soil property maps, as well as climate and land use maps, make up figures 1 to 15. They are based on SSURGO data, and, where SSURGO data are unavailable, the STATSGO2 (State Soil Geographic) database. The maps were made by querying component diagnostic features, diagnostic horizons, and taxonomic class in Soil Data Access. By using different queries, it was possible to extract features that were otherwise missed by using one query alone due to inconsistent data population. For example, plinthite might not be populated as a component diagnostic feature, but a search for "plin*" in the taxonomic subgroup would reveal its presence.

## Tables

MLRA data on size, elevation, temperature, freeze-free periods, and precipitation were added to each LRR section. The elevation tables provide information in both meters and feet on the low, the 10th, 50th, and 90th percentiles, and the high. Elevation is overgeneralized by the tables for mountainous regions with narrow canyons and mountain peaks and for low-relief areas with quarries and landfills. In this case, the narrative information provides a more accurate account of the local topographic diversity. Similarly, where climatic data provided by the tables was too coarse to capture the local diversity in mountainous regions, local data provide a more accurate description of rainfall, temperature, and freeze-free days. The tabular data, however, provide more statistical information about range and central tendency. In addition, they provide a database with continental-scale uniformity that is useful for modeling.

Sources of the elevation data for the conterminous United States, Hawaii, Puerto Rico, and the U.S. Virgin Islands are USGS 3D Elevation Program 1/3-arc-second resolution tiles, which represent the best available coast-to-coast raster elevation data for the Nation. For Alaska, small portions of the State only had 1-arc-second resolution data available, which were resampled to 1/3-arc-second. The elevation data were obtained in September and October of 2019, mosaiced for each region into a seamless data set, and projected to a local reference system at 10-meter horizontal resolution. Elevation values are reported from the source in meters. Each MLRA was subset from its source layer, so all pixel values were evaluated for the minimum, the 10th, 50th, 90th, and maximum quantiles, and the mean. These values were converted to feet using meters * 3.28084. The 10th quantile was rounded down to a multiple of 10, and the 90th quantile was rounded up to a multiple of 10. Median and mean were rounded to a multiple of 5. The elevation information for the remaining Pacific Basin territories is the same as that in the 2006 edition of the handbook.

Sources of climatic data are from the Parameter-elevation Regressions on Independent Slopes Model (PRISM) developed by the Spatial Climate Analysis Service at Oregon State University, in cooperation with the NRCS National Water and Climate Center (NWCC). The period of record for the climate normals covered varying dates depending on region. For the conterminous United States and Alaska, the period was 1981-2000; Puerto Rico, 1963-1995; the U.S. Virgin Islands, 1971-2000; and the Pacific Basin Islands, 1971-2000. These data were used to generate mean annual precipitation (MAP) and mean annual air temperature (MAAT) maps for the lower 48 States (figs. 6 and 7) as well as the climate summaries presented in the tables.

Precipitation values are reported from the source as millimeters. Each MLRA was subset from its source layer, so all pixel values were evaluated for the minimum (rounded down to a multiple of 10), the 10th, 50th, 90th, and maximum (rounded up to a multiple of 10) quantiles, and the mean. The untransformed quantiles were converted to inches using mm / 2.54 and were rounded to the nearest integer.

Temperature values are reported from the source as degrees Celsius. Each MLRA was subset from its source layer, so all pixel values were evaluated for the minimum, the 10th, 50th, 90th, and maximum quantiles, and the mean and all were rounded to 0.1 degree Celsius. The quantiles were converted to

degrees Fahrenheit using degree Celsius * 1.8 + 32 and were rounded to the nearest integer.

Frost-free day (FFD) estimates were created for the conterminous United States using daily minimum air temperature values (PRISM Group). For each year, and at each pixel, the day of last freezing temperature (0 degrees Celsius) in spring (January to July) and day of first freezing temperature (0 degrees Celsius) in fall (August to December) were calculated. The FFD estimates are based on the number of days between pixel-wise evaluation of the median date of the last frost day in spring and the median date of the first frost day in fall. Each MLRA was subset from its source layer, so all pixel values were evaluated for the minimum, the 10th, 50th, 90th, and maximum quantiles, and the mean for the length of growing season in days.

## Land Use Charts

Bar charts are included in the LRR and MLRA descriptions to augment the land use map (fig. 8) and narratives. Most of the categories are self-explanatory (e.g., corn, soybeans, and rice). However, some categories, are not. For example,"Shrubs" contain some woodlands with trees that are taller than 6 feet (e.g., pinyon, juniper, and barberry). Other categories that are not self-explanatory include the following:

*Developed, Open Space*.—Areas that have a mixture of some constructed materials but are mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent of total cover. These areas commonly include large-lot, single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.

*Developed, Low Intensity*.—Areas that have a mixture of constructed materials and vegetation. Impervious surfaces account for 20 to 49 percent of total cover. These areas commonly include single-family housing units.

*Developed, Medium Intensity*.—Areas that have a mixture of constructed materials and vegetation. Impervious surfaces account for 50 to 79 percent of the total cover. These areas commonly include single-family housing units.

*Developed High Intensity*.—Highly developed areas where large populations reside or work. Examples include apartment complexes, row houses, and commercial or industrial areas. Impervious surfaces account for 80 to 100 percent of the total cover.

The sources for land use data are as follows:

*Conterminous United States*—National Agricultural Statistics Service, 2019
*Hawaii*—NOAA Coastal Change Analysis Program, 2010-2011
*Alaska*—USGS LANDFIRE, 2014
*Puerto Rico and the U.S. Virgin Islands*—NOAA Coastal Change Analysis Program, 2010-2012
*Guam, the Northern Mariana Islands, and American Samoa*—NOAA Coastal Change Analysis Program, 2004-2016
*The Republic of Palau*—USFS Land Cover Monitoring, 2005
*The Marshall Islands*—USFS Land Cover Monitoring, 2008

For each MLRA, the top 10 classes were identified. The classes were sampled using a regular (systematic) method at a density of 0.0005 to 0.005 points per acre. Many MLRAs did not have 10 classes represented. Any class with less than 1 percent of the area was lumped into "Other." Where "Other" classes make up significant proportion, there are numerous classes with less than 1 percent coverage in the MLRA. Efforts were made to keep the colors of the histogram charts the same as the source spatial layer. The colors of the histogram are from the color map of the spatial layer from which they were developed, with the exception of the USFS sourced layers whose colors were matched to the colors in NASS (National Agricultural Statistics Service) and other land use sources.

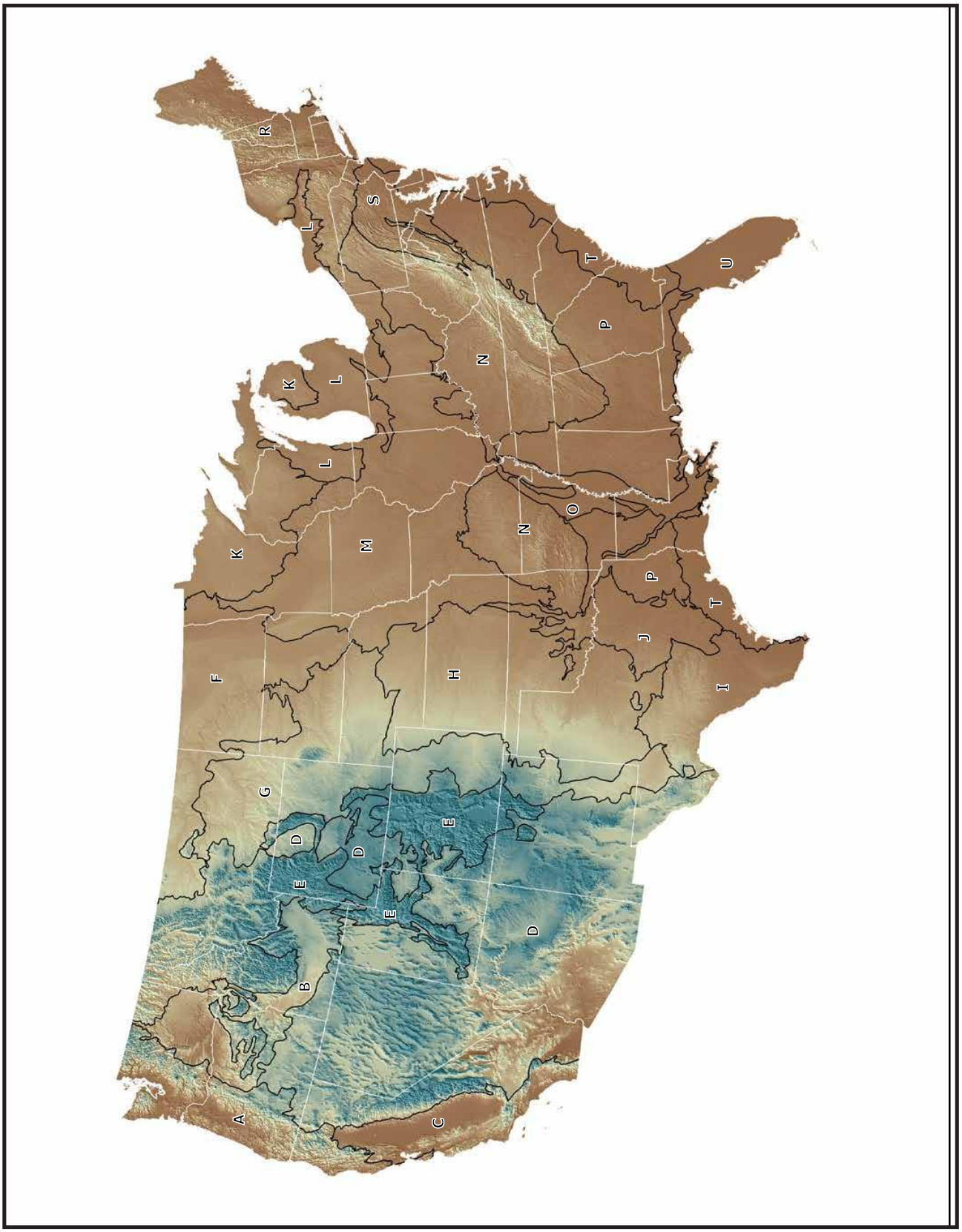


**Figure 1: Boundaries of the land resource regions (LRRs) of the conterminous United States (CONUS).**

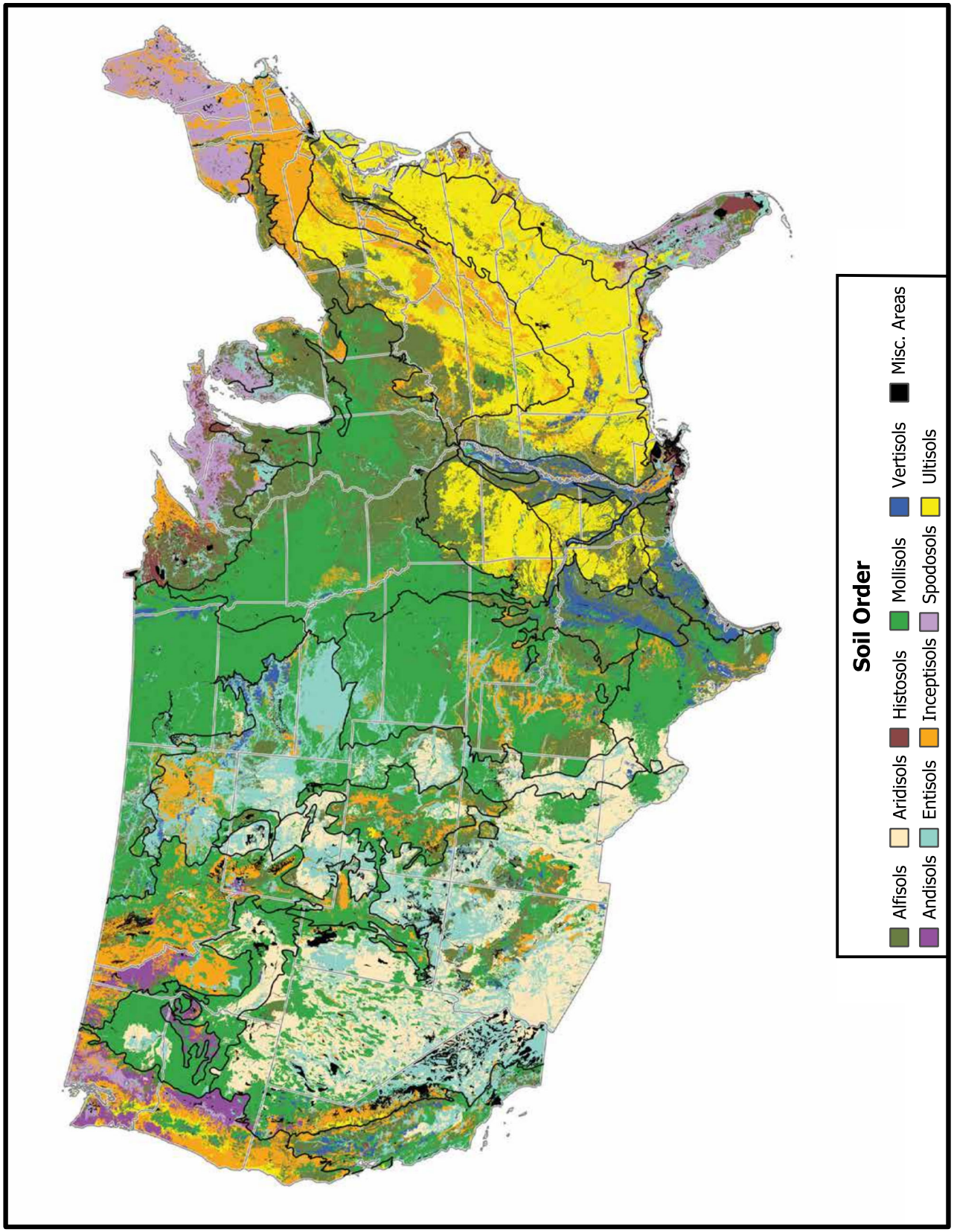


**Figure 2: Dominant soil orders of the conterminous United States based on SSURGO and STATSGO2 mapping. LRR boundaries are in black.**

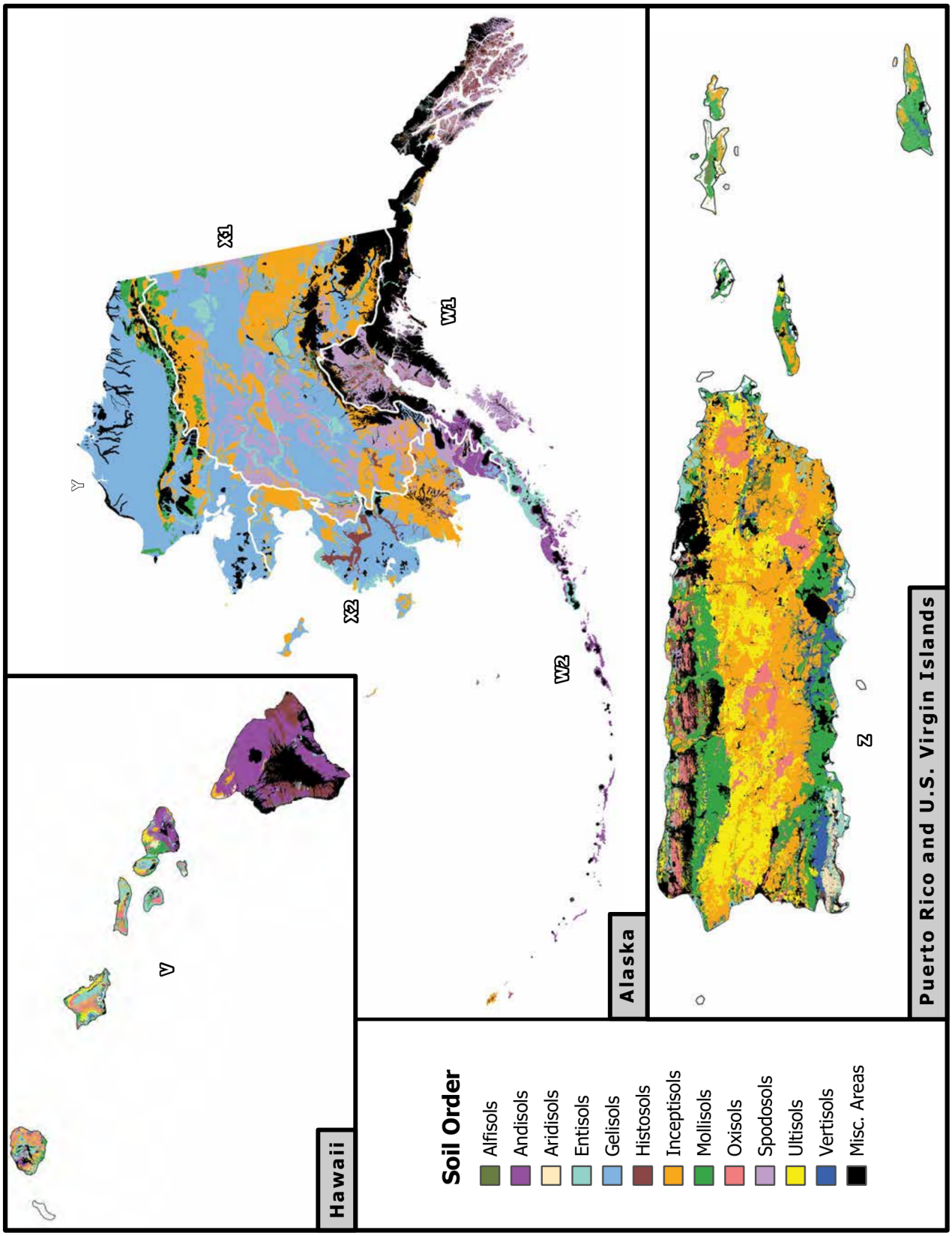


**Figure 3: Dominant soil orders of Hawaii, the Caribbean, and Alaska. LRR boundaries are in white.**

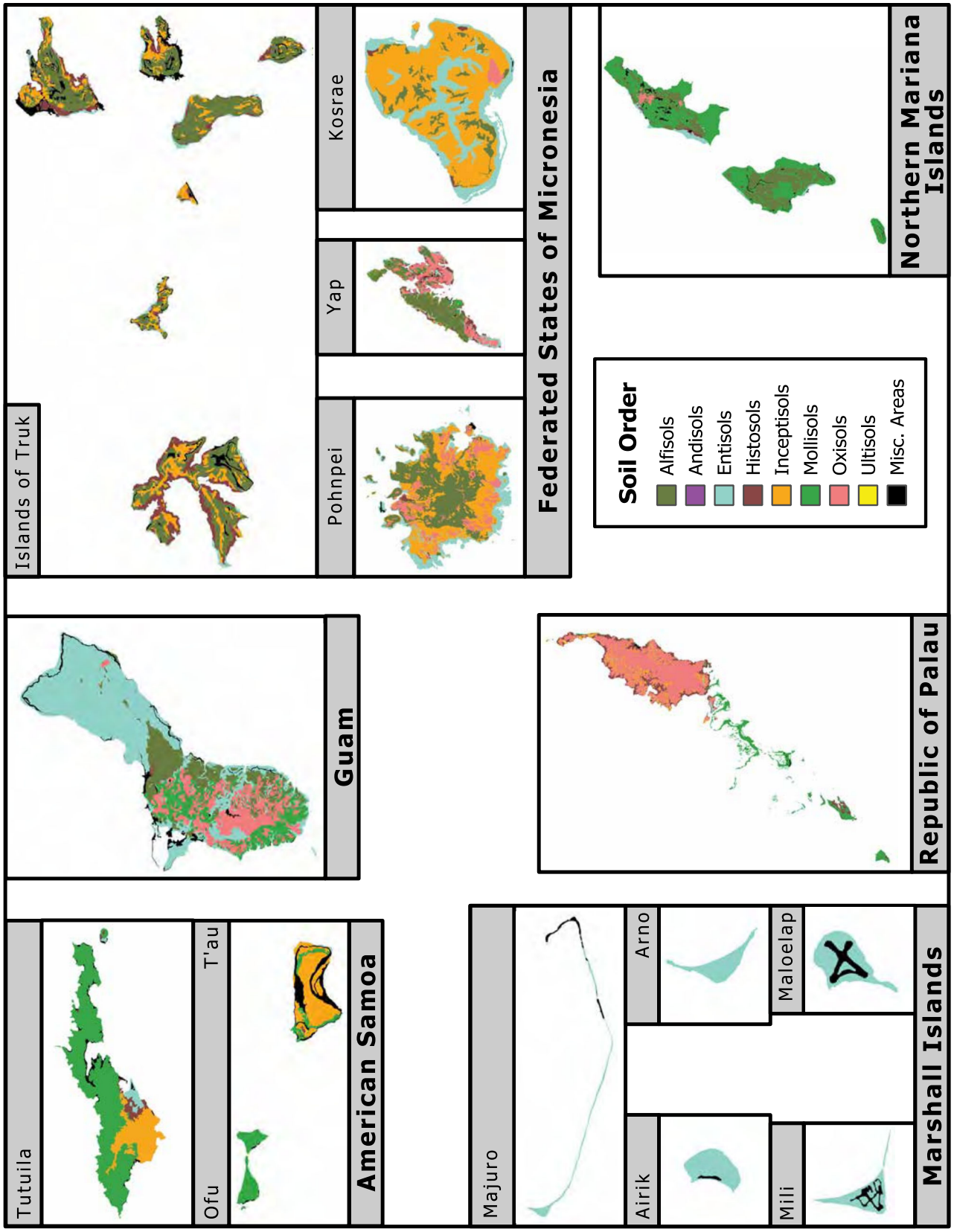


**Figure 4: Dominant soil orders of the Pacific Basin Islands (LRR Q).**

Major Land Resource Areas of the United States